Oregon Health Authority
Environmental Health Assessment Program (EHAP)

Health Consultation

Willamette Cove East Parcel Beach

Portland, Oregon

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Prepared by
Oregon Public Health Division
Environmental Health Assessment Program

Public Comment

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Foreword

This report was supported by funds from a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR), U.S. Department of Health and Human Services. This has not been reviewed and cleared by ATSDR.

The Environmental Health Assessment Program (EHAP), part of the Oregon Health Authority, partners with communities affected by hazardous waste in Oregon. EHAP works to assess and prevent human exposure to contamination at sites listed on the National Priorities List (also known as Superfund sites) and other hazardous waste sites that impact communities.

Individuals, organizations, or governmental agencies may request EHAP's assistance to assess and communicate the health risks of hazardous waste sites in Oregon. EHAP works with many partners, including the Environmental Protection Agency (EPA), Oregon Department of Environmental Quality (DEQ), ATSDR, local health departments, and most importantly, the affected communities to assess and prevent exposure to hazardous chemicals.

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Summary

Introduction	At Willamette Cove, EHAP's purpose is to serve the public by using the best science, taking responsive public health actions, and providing trusted health information to prevent people from coming into contact with harmful toxic substances.
Overview	EHAP reached *three* important conclusions in this Health Consultation.
Conclusion 1	*Incidentally swallowing lead-containing beach soil at the East Parcel beach at the Willamette Cove site on a regular basis could harm the health of children and adults who use this area (156 days per year for children and 182 days per year for adults).* Due to the levels found, EHAP considers the East Parcel beach an area of public health concern.
Basis for Decision	High levels of lead measured in the soil could cause decreased intelligence and impaired neurobehavioral development in children and fetuses. There is no "safe" level for blood lead concentration in children or adults.
Next Steps	EHAP recommends that people not go on the site. However, if they do, make sure to: • Avoid direct contact with soil on the East Parcel beach. • Wear shoes and avoid sitting in the soil. • Remove shoes before entering the home to avoid tracking soil into living areas. EHAP will: • Evaluate future data, as they become available, for lead and other chemicals on the East Parcel beach.
Conclusion 2	*There is not enough evidence to conclude that people could experience health effects from contacting dioxin-containing surface soil on the East Parcel Beach of the Willamette Cove.*
Basis for Decision	This is because EHAP does not have evidence that people are coming into contact with dioxin-contaminated soil on a regular basis.
Next Steps	EHAP will: • Further characterize dioxin contamination in the upland area, when data become available. • Evaluate contamination data for other chemicals in the upland area.
Conclusion 3	*Trespassing on the upland area near the East Parcel beach on old scaffoldings, walking or playing on the East Parcel beach where metal debris is sticking out of the ground, or going into the water along the East Parcel where numerous underwater hazards are present could result in physical injury.* This is a physical safety hazard.
Basis for Decision	There are structures near the East Parcel beach that are old and unmaintained. People could also be cut by or trip over pieces of metal sticking out of the ground. People could trip on or be cut by physical hazards in the water; boaters could collide with underwater hazards.

Next Steps EHAP recommends that people who use the site:

- Avoid playing on or going near areas where physical hazards are present on or near the East Parcel Beach.

EHAP will:

- Communicate with partner agencies to reduce access to physical hazards in the area.

Purpose and Public Health Issues

The Oregon Office of Environmental Public Health's Environmental Health Assessment Program (EHAP) has prepared this Health Consultation (HC) regarding Willamette Cove in Portland, Oregon, at the request of the Oregon Department of Environmental Quality (DEQ). This HC addresses the potential public health impacts of exposure to the contaminants of lead, dioxin, and physical hazards on the East Parcel beach at Willamette Cove.

Background

Site Description

On December 1, 2000, the US Environmental Protection Agency (EPA) and Oregon DEQ designated Portland Harbor a Superfund site under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA). As part of the Superfund investigation process, EHAP investigated environmental exposures and human health at multiple sites within Portland Harbor. Willamette Cove is within the boundaries of the Portland Harbor Superfund site.

The Willamette Cove property consists of 27 acres (Figure 1) along the east bank of the Willamette River, between river miles 6 and 7. It is bounded by the Willamette River to the southwest and a steel facility to the northwest. The Union Pacific rail line forms the northern boundary of the site. The Burlington Northern Santa Fe (BNSF) rail line and the approach to the Willamette River railroad bridge form the east side of the site boundary. On the opposite side of the BNSF tracks is the former McCormick and Baxter Creosoting Company, a federal Superfund facility. The Cathedral Park neighborhood of Portland is on the other side of the rail line; some residences are less than 500 feet from the site.

The site is elongated, from east to west, along the Willamette River. The Willamette Cove site is divided into an East Parcel, a Central Parcel, and a West Parcel (Figure 1). The site also consists of two distinct ecological areas: the shoreline and the upland area.

The shoreline is unique because there are two sandy beach areas in the East and Central Parcel, and beaches are rare along the Willamette River. The East Parcel beach is where the actual "cove" is found (Figures 2 and 3) and is the focus of this Health Consultation. This beach is relatively far from where site personnel or police can enter the site, and is a popular place for people to congregate. This area contains abandoned pilings and industrial demolition debris.

The upland area of the site is heavily vegetated and many trails traverse the upland area (Figure 4). Although signs are posted to discourage trespassing and the trails are blocked to vehicle access, many people use the trails in the upland area. The East Parcel and Central Parcel beaches can be accessed by these trails.

Both the shoreline and upland area is owned and managed by Metro, the regional governmental agency for the Portland area.

Site History

Since the 1930s, there has been significant industrial activity at the Willamette Cove site, including several industrial operations. The site was used as a lumber and plywood mill, a cooperage (barrel making) plant, and a shipbuilding and ship maintenance dry dock facility owned and operated by the Port of Portland. Some of these industrial activities continued until the 1960s (DEQ, 2012). Because most of these activities pre-dated most environmental reporting requirements, the specific manner and time of chemical releases on the site are not known. Since there was a legacy of ship construction, EHAP believes that chemical releases occurred in water near the shore, and on the shore itself. In addition, wood-preserving chemicals from the adjacent

McCormick & Baxter site have migrated in sediment and groundwater into the south end of the site (DEQ, 2012). In the 1960s and 1970s, industrial activity on the site was discontinued. By the early 1980s, the remaining buildings on the site were demolished (Ash Creek, 2007). Since then, the land on the site has re-vegetated. Vegetation is quite dense in some places, with a mixture of native and invasive plants.

Metro acquired Willamette Cove in 1996 with the intent to develop the site into an urban natural area with passive recreation opportunities (City of Portland, 2009). Initially, they planned to encourage and restore native vegetation and build a multi-use trail through the site as part of the Willamette River Greenway. However, no restoration or development activity has taken place.

Past cleanup activities

There have been previous cleanup actions at the site. In 1999, an abandoned underground storage tank and 127 tons of oil-contaminated soil was removed from the upland area. In 2004, test pits were dug in the East Parcel beach area and petroleum products were discovered in these pits. When the shoreline along the neighboring McCormick & Baxter site was capped, part of the shoreline of the East Parcel beach was also capped to prevent further migration of McCormick and Baxter contamination to the Willamette Cove beaches and the Willamette River. This cap prevents people from coming into contact with wood-preserving contaminants.

When the Portland Harbor Public Health Assessments (PHAs) were released in 2006 and 2011, EHAP only had limited data about contamination at Willamette Cove. New sampling data only became available as the 2011 "Recreational Use" PHA was being finalized.

Site Visit

EHAP visited Willamette Cove in November 2010, August 2011, and July 2012. Access to the site from Edgewater drive is restricted by a secured gate and concrete barriers. According to Metro personnel, this locked gate has in the past been breached multiple times. Access to this gate is shared with other agencies and railroad contractors. There are numerous trails and unofficial entrances to the site; some of these trails can be seen in the overhead map in Figure 1. EHAP observed that some of the "No Trespassing" signs had been defaced or were covered by growing vegetation. Although trails were blocked to motor vehicles, they can be easily accessed on foot and on bicycle. During the site visits, EHAP also observed people using the site. During the 2011 site visit, the Metro site manager had to ask people to leave the upland area. Also during this visit, EHAP observed bicycles and bicycle trailers full of peoples' personal belongings, parked on the East Parcel beach (Figure 5). There were also multiple campfire remnants on the beach, one of which was used for cooking (Figure 6). There was one boat anchored in the cove (Figure 7), and a hand-made raft was parked on the beach, indicating boat-to-shore activity (Figure 7).

Demographics

The people potentially affected by contaminants from Willamette Cove are people who trespass onto the site. It should be noted that while this site is under the ownership of a public entity, there is no public access allowed on this site. “No trespassing” signs are posted throughout the upland area of the site. Metro, the site owner, routinely patrols this area, telling people to leave. EHAP identified at least five different categories of people who routinely visit the site: (1) Transient populations; (2) Groups of partying teenagers and young adults; (3) People coming ashore on boats; (4) People who are out walking their dogs, or biking, walking or running through the site; and (5) people who come to fish from the shore. The East Parcel beach often attracts boaters since it is protected from river currents and ship traffic. Many transient boaters (*i.e.*, people who use small boats as their primary home) use this as a place to anchor their vessels (Figure 7). In spring 2011, DEQ observed a boat that became stranded on the beach after the river level dropped. The owners re-floated the boat by digging a large amount of sand away from under the boat (Figure 8).

Figure 1. 2007 map of the Willamette Cove site. (Photo courtesy of Ash Creek Associates)

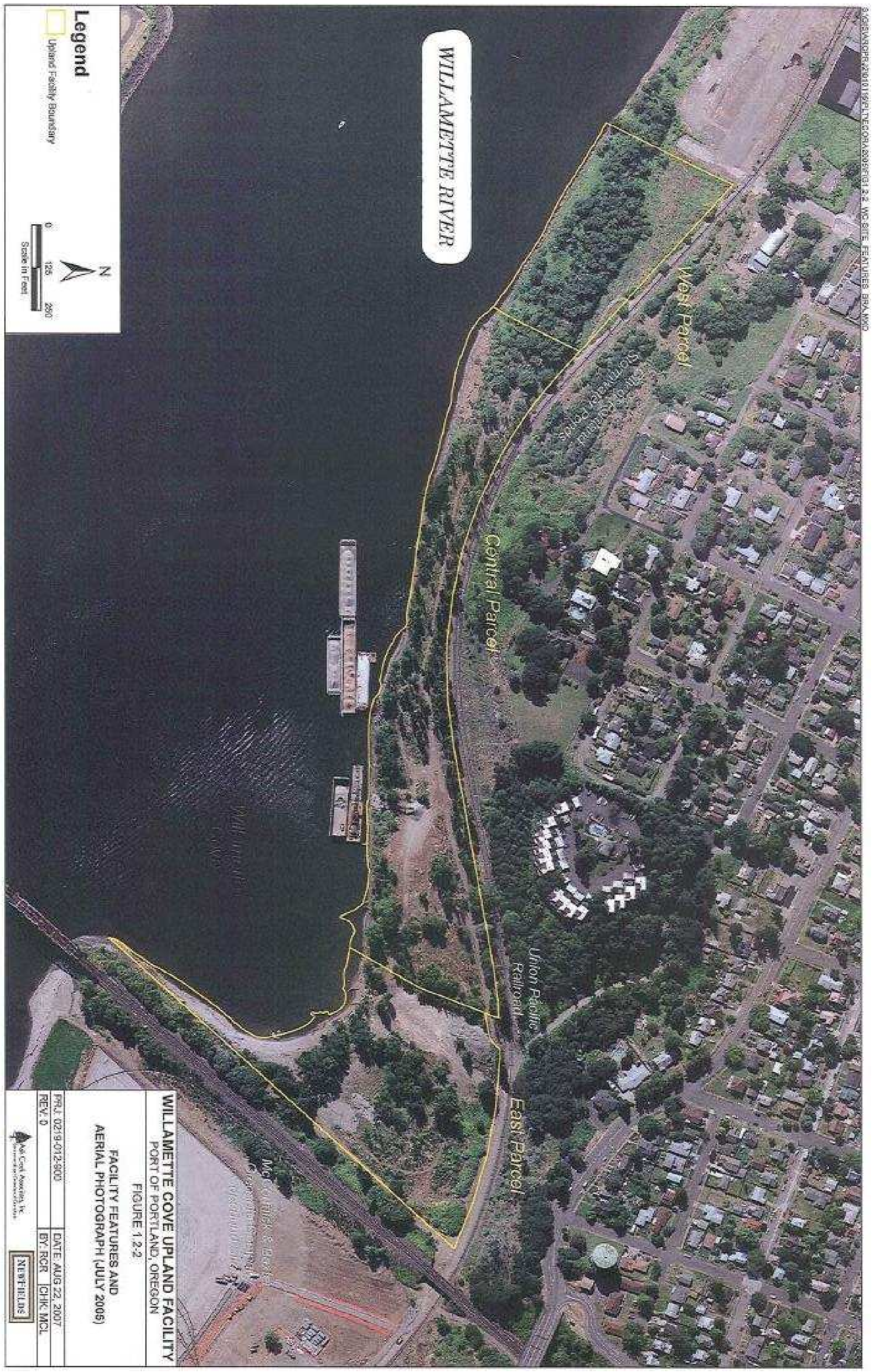

Figure 2. An overhead photo of the East Parcel section of Willamette Cove.

Figure 3. The East Parcel beach of Willamette Cove (2010).

Figure 4. A path that crosses through the upland portion of the Willamette Cove site. Some of these paths lead to the beach areas along the river (2010).

Figure 5. Bicycles parked on the east parcel beach of Willamette Cove. To the left of the bicycles are a sleeping bag and a crate with living supplies (2011).

Figure 6. Remnants of a fire used for cooking at the east parcel beach of Willamette Cove. Remnants of fire pits have been observed at both East Parcel and West Parcel beaches (2011).

Figure 7. Boats anchored near the East Parcel beach of the Willamette Cove site. A handmade raft sits near the shore. These boats have been observed being anchored in the cove for long periods of time (2011).

Figure 8. A stranded boat on the East Parcel beach of Willamette Cove. To the right of the boat is a large pile of displaced soil removed during an attempt to re-float the boat (2011).

Figure 9. Metal and concrete debris sticking out of the ground at the East Parcel beach of the Willamette Cove site (2011).

Figure 10. An old scaffolding structure near the East Parcel Beach (2010).

Discussion

Nature and Extent of Contamination

This section describes the types of data that EHAP considered in deciding whether or not people's health could be harmed by chemical contaminants found in the East Parcel beach. This is also the section where details about the assessment process and results can be found.
All environmental sampling data used in this assessment were obtained using EPA-approved methods and technology by certified professionals and technicians. EHAP considers these data of adequate quality to support the conclusions of this report.

The data used for this health consultation were collected by the Port of Portland in 2007 and 2010, as part of a source control evaluation (Ash Creek, 2011; LWG, 2008). These samples were collected from the surface of sandy areas on the East Parcel beach, below the high water mark. Some samples were taken from areas of heavy vegetation, from test pits (*i.e.*, several feet deep), or from areas covered in steep rip-rap material. EHAP did not evaluate samples that were collected from areas where people are very unlikely to go. EHAP evaluated two beach soil samples that were collected in 2008 and 2010. At DEQ's request, EHAP also evaluated one sample from the upland area that was less than 100 feet from the East Parcel beach. The samples taken from the East Parcel beach used in this HC are listed in Table 1.

Table 1 – Concentrations of lead and dioxin in samples taken from the East Parcel beach.

Sample Name	Lead Concentration (ppm)	Dioxin Concentration (ppm)[a]
Wharf Beach -1[b]	NA[c]	0.0000015
LW3-GEC1	**13400**[d]	0.0000000125
WC – 3 Surface	Not Tested	**0.0057**[e]

a - Although several dioxin and furan congeners were analyzed in soil, only a single value, called a dioxin toxic equivalent (TEQ), is presented in this health consultation. Each dioxin/furan, or dioxin-like compound, is multiplied by a Toxic Equivalency Factor (TEF) to produce the dioxin TEQ.
b – These are the names of the samples as listed in the Ash Creek (2011) report.
c – Due to quality control problems, the concentrations of lead in these samples was not valid.
d – Above the EPA's residential soil screening level of 400 ppm.
e – Above ATSDR's child chronic Environmental Media Evaluation Guide (EMEG) for dioxin (0.00005 ppm).

When the maximum measured concentrations of a given contaminant were higher than the comparison value (CV), that contaminant was identified as a "contaminant of potential concern" (COPC). It is important to note that just because a COPC has been identified, it does not mean that we expect harmful health effects from exposure to that contaminant. Rather, it simply flags that these contaminants for closer evaluation. In the East Parcel beach sample, the level of lead exceeded the CV, which is EPA's Residential Screening Level (RSL) of 400 parts per million (ppm). The dioxin concentrations on the East Parcel beach were below the CV, which is ATSDR's child-chronic Environmental Health Evaluation Guide (EMEG) of 0.00005 ppm; the dioxin sample collected from a densely vegetated area near the beach was above the dioxin CV. For more information about the CVs used, see Appendix A.

Exposure Pathways

In order for a chemical contaminant to harm human health, there must be a way for people to come into contact with the chemical. An "exposure pathway" describes how a chemical moves from its source and comes into physical contact with people. An exposure pathway has five elements:

(1) A contaminant source or release
(2) A way for the chemical to move through the environment to a place where people could come into contact with it
(3) A place where people could contact the contaminant
(4) A route of exposure to a contaminant (breathing it, swallowing it, absorbing it through the skin)
(5) A population that comes into contact with the contaminant

An exposure pathway is "completed" if all five of the elements are known to be in place and occurring. If it is unknown whether one or more of the elements is in place, then it is called a "potential" pathway. If it is known that one of the five elements is *not* in place, then that pathway is "eliminated."

<u>Completed Exposure Pathways</u>

Table 2 describes the completed exposure pathways for the Willamette Cove East Parcel Health Consultation.

Table 2. Completed Exposure Pathways

Pathway	Time	Source	Media and Transport	Point of Exposure	Route of Exposure	Exposed Population
Contact with soil with elevated lead levels	Past Present Future	Historical industrial activity	Surface layer of soil	Contaminated areas in the East Parcel Beach area	Swallowing, touching the skin	People who trespass on the site

<u>Potential Exposure Pathways</u>

Table 3 describes the potential exposure pathways for the Willamette Cove East Parcel HC.

It is not known if people access the area where the high dioxin soil sample was taken. Although this sample indicates dioxin levels that are higher than its environmental screening value, it is much less likely that people will come into contact with this area than they would the East Parcel beach because the sample was taken from an area covered by heavy vegetation. To reach the area, EHAP staff had to walk over steep rip-rap (*i.e.*, large pieces of rubble) and through heavy vegetation (much of this vegetation is blackberry bushes with thorns). Vegetation also obstructs the approach from the upland side of the site. There was only a small amount of exposed ground in the spot where this sample was taken.

In the absence of concrete evidence to the contrary, EHAP assumed that some people have come to this particular spot where the sample was taken. Therefore, EHAP assessed the potential health risks to individuals who may hypothetically come into contact with the soil.

Table 3. Potential Exposure Pathways

Pathway	Time	Source	Media and Transport	Point of Exposure	Route of Exposure	Exposed Population
Contact with soil in the area with elevated dioxin levels	Past Present Future	Historical industrial activity	Surface layer soil	A small, contaminated area in the upland area, less than 100 feet from the East Parcel beach	Swallowing, touching the skin	People who access this area (unknown if people are actually here)

<u>Eliminated Exposure Pathways</u>

Table 4 shows eliminated exposure pathways identified for the Willamette Cove East Parcel HC.

Table 4. Eliminated exposure pathways.

Pathway	Time	Source	Media and Transport	Point of Exposure	Route of Exposure	Exposed Population
Inhalation of contaminants from site	Past, Present, Future	Historical industrial activity	Dust carried in wind to places where people could inhale it (the site is heavily vegetated and dust is unlikely)	Beaches, upland area, or offsite properties adjacent the site	Breathing in airborne dust	People who trespass on the site, residents of properties adjacent to the site

Most of the dust that is visible in a dust storm, or when a vehicle drives down a dirt road, consists of particles that are too large to go very deep into the lungs. These larger particles are trapped in mucus that lines the respiratory tract and are carried back up to the throat where they are swallowed. Therefore, in most cases, the dose of a contaminant from incidental swallowing of soil is much greater than the dose from inhaling it into the lungs.

It is also unlikely that the site will remain dry enough for a sufficient amount of dust to enter the air and migrate off site. Portland receives rain, on average, 154 days per year. In addition to rain, the entire East Parcel beach is less than 100 feet from the shore of the Willamette River, which keeps much of the soil saturated.

In addition, the Willamette Cove East Parcel beach is surrounded by the upland area; it is heavily vegetated with mature, tall trees and extremely dense ground vegetation. It is unlikely that any dust blown from the East Parcel beach can penetrate through this area to residences. Finally, the nearest residences in the Cathedral Park neighborhood are located above a heavily vegetated bluff adjacent the northern boundary of the site. The East Parcel beach is over 500 feet from the nearest residence.

For the reasons outlined above, breathing contaminated dust was eliminated as an exposure pathway. This pathway was not further evaluated in this public health assessment.

Public Health Implications

To accurately assess whether or not environmental contaminants could harm the health of people who are exposed to them, it is necessary to determine how much of each contaminant could be getting into people's bodies. For this assessment, EHAP calculated doses for each of the COPCs based on the specific exposure scenarios. These exposure scenarios were developed using information and assumptions about the age of the individuals accessing the site and type of activities known to occur there.

Dioxin Exposure

As previously explained in the pathways analysis, exposure to dioxin is a *potential exposure pathway*. The area where dioxin was measured at high levels is not on the beach and is obstructed by dense vegetation and steep concrete rip-rap. EHAP does not know whether people recreate or play in this area. It is important to note that only people actually sitting or playing in this hard to reach area would come into contact with dioxin-contaminated soil.

Although several dioxin and furan congeners were analyzed in the soil sample, only a single value, called a dioxin toxic equivalent (TEQ), is presented in this HC. Each dioxin/furan, or dioxin-like compound, is multiplied by a Toxic Equivalency Factor (TEF) to produce the dioxin TEQ. EHAP uses a process similar to EPA's human health risk assessment process to calculate the doses people might get from contact with dioxin at a site.

The sample from the upland area next to the East Parcel beach was the only dioxin sample that was higher than the comparison value.

<u>Dose Calculation</u>

Dose calculation requires EHAP to make assumptions about the frequency and intensity with which people contact dioxin. Wherever possible, site-specific information is used, but when that information is not available, EHAP uses default values that are established by ATSDR or EPA. Where default values are unavailable, EHAP uses best professional judgment. See Appendix B for details about the methods and assumptions used to calculate doses of dioxin.

Children can potentially contact dioxin in soil at Willamette Cove through two routes. For example, a child playing in contaminated soil could swallow dioxin in the soil particles and absorb dioxin from the soil particles on their skin. The most protective way to calculate a total dose is to add the calculated dioxin doses from swallowing and skin contact together.

For the dioxin exposure analysis, EHAP used one scenario of a person playing directly in this area. Since there are not enough samples to statistically calculate an overall concentration, EHAP used the sample with the maximum concentration (0.0057 ppm) to calculate the dose and risk to an adolescent child (age 11 years and up) playing directly in this area. The exposure scenario assumes that an adolescent would be playing in this area one day a week for two continuous years, and incidentally swallowing 100 mg of soil each time they are there. This scenario also takes into consideration skin exposure; EHAP assumed that the hands, upper arms, and lower legs of an adolescent would be exposed to the soil while they are playing here. Appendix B details the methods and assumptions used to calculate the doses and risk.

There is uncertainty about whether people actually trespass into the area where high dioxin levels were found. It is less attractive than the beach around the cove, and people must cross obstacles to reach this area. Because of this reason, an exposure scenario was chosen that reflects this. There is no specific risk assessment guidance for trespassers. Because not all sites provide the same opportunities and access for trespassers, scenarios must be developed on a site-specific basis (EPA, 1991). Trespassing scenarios require best professional judgment based on the individual characteristics of each site.

Non-cancer risk

Non-cancer risk, the risk of any health problem other than cancer, was calculated by dividing the total calculated dose for dioxin for each scenario (*i.e.*, by swallowing and from skin contact) by the health guideline for dioxin. A health guideline is the daily dose of a chemical, below which scientists consider it unlikely to harm people's health. EHAP followed ATSDR guidance (ATSDR, 2005) by using health guidelines, call Minimal Risk Levels (MRLs), whenever available. A MRL is an estimate of daily human exposure to a substance that is unlikely to cause non-cancerous health effects during a specific amount of time. The MRL is set well below levels that are known or anticipated to result in non-cancerous, adverse health effects (ATSDR, 2005). ATSDR's chronic MRL for dioxin is 1E-09 (0.000000001) mg/kg/day.

EHAP divided calculated doses by the MRL, also called a "health guideline" (see equation below). The resulting number, for each pathway, is called the hazard quotient (HQ). By adding together all the HQs for each pathway, the Hazard Index (HI) is identified. If the HI or the HQ in any given scenario is greater than 1, it is an indication that the estimated dose is above the safe dose, and there could be concern for potential health effects (EPA, 1989). An elevated HI only tells us there is *potential* for adverse health effects, and that further evaluation should be considered. A HQ or HI below 1 indicates that the estimated dose is below the safe dose and non-cancer effects are unlikely.

Hazard Quotient = Calculated Dose ÷ Health Guideline (MRL)

The HQs for swallowing and having skin contact with soil that contains dioxin were included in calculating the HI.

EHAP assumed that an adolescent child (age 11 years or greater) would access this dioxin-contaminated area 52 days per year, swallowing 100 mg of soil each time they are playing, and getting soil on their hands, forearms, and lower legs. The estimated total dose from swallowing and absorbing dioxin is 1E-09 (0.000000009) mg/kg/day. The HI for non-cancer effects is 1, approximately the same value as the threshold for increased potential of health effects.

As previously stated in the pathways analysis, the area where this soil sample was taken is surrounded by dense vegetation and is upland from the Each Parcel beach. Because of the location, EHAP believes that this exposure scenario is very conservative, *i.e.*, it overestimates actual exposures, if they are actually occurring. Because the HI does not exceed 1, EHAP does not believe that people accessing this site would experience adverse health effects. Due to the small number of samples, however, the extent of dioxin contamination is not fully known.

An acute exposure, or an exposure of 14 days or less, would result in an even lower HI at this concentration. Therefore, EHAP concludes that the dioxin concentration from this one soil sample is not expected to cause any non-cancer health problems for children.

<u>Cancer Risk</u>

Theoretical cancer risk was calculated by multiplying the calculated cancer dose (cancer dose is averaged over a 78-year lifetime instead of the duration of exposure) by the cancer slope factor (CSF) (see equation below). EHAP used EPA's oral cancer slope factor of 1.5×10^5 (15,000) per mg/kg/day (EPA, 2000).

Cancer Risk = Calculated Cancer Dose x Cancer Slope Factor

Cancer risk is expressed as a probability, which can be thought of in terms of additional cancer cases in a theoretical population where everyone in that population would get the same dose of the same chemical every day over their entire lifetime. EHAP considers 1 additional case of cancer out of 10,000 (1×10^{-4}) people exposed every day for an entire lifetime to be low risk. A cancer risk of 1 cancer case out of every 100,000 people (1×10^{-5}) would be a very low risk. A cancer risk out of 1 additional case out of 1,000,000 (1×10^{-6}) would be a negligible risk.

For cancer effects, the lifetime cancer risk for an older child was 9×10^{-5}, or approximately 9 additional cases of cancer out of 100,000 people. This does not exceed EHAP's threshold of one additional case of cancer out of 10,000 people (1×10^{-4}), and is considered to be a low level of additional cancer risk.

Lead Exposure

The method of evaluating risks from exposure to lead differs from methods used in evaluating other chemicals, where exposure doses are calculated and compared to health-based guidelines. Because people are exposed to lead from a variety of environmental sources, modeling is typically used to predict the blood lead concentration from exposure to lead contamination at a site and exposures from other environmental sources. Young children (0-7 years) and the developing fetus are the most sensitive receptor population to the toxic effects of lead. Blood lead levels as low as 5 μg/dL are associated with decreased intelligence and impaired neurobehavioral development in growing children (CDC, 1991), and research has shown that measured health effects can occur at levels as low as 2.5 μg/dL (EPA, 2000). There is no demonstrated safe level of lead in blood.

EHAP uses 5 μg/dL as the threshold blood lead level for adverse health effects in children. This means that when exposure to lead will result in blood lead concentrations higher than 5 μg/dL, action should be taken to eliminate exposure. The Center for Disease Control's (CDC) reference value for blood lead levels in children is 5 μg/dL. For adults, it is 25 μg/dL. EHAP evaluated lead exposures at Willamette Cove using the recommended EPA's and ATSDR's prediction modeling of blood lead concentrations in adults and in children.

Lead was the primary contaminant of concern in beach soil at Willamette Cove's East Parcel beach. The lead sample that EHAP evaluated in this health consultation was measured at 13,400 ppm. Since the maximum concentration of lead in beach soil exceeds the comparison value (CV) of 400 ppm by many times, EHAP looked at the public health implications of contact with lead contaminated soil on the East Parcel beach.

Adults

The Adult Lead Model (ALM) is used to predict blood lead levels in adults. For adults, EHAP used the following exposure assumptions to estimate risks to adults using the East Parcel beach:

- A soil ingestion rate of 100 mg/day was used. Since cooking, eating, and digging in the soil has been observed here, EHAP used the reasonable maximum exposure (RME) of 100 mg/day for adult soil ingestion.
- Due to the small number of samples, EHAP used the maximum detected value, 13,400 ppm, as the Exposure Point Concentration (EPC).
- An exposure frequency of 182 days, or six months, per year. This is a professional judgment that assumes a transient person spends half their time on the East Parcel beach. This exposure frequency is based on the large amount of activity observed at the site, the degree of accessibility, and the fact that the area is difficult to monitor. This exposure frequency is meant to be conservative, or protective of human health.

For activities involving these exposure factors and the EPC of lead in beach soil, the total estimated blood lead for an adult is 33.6 µg/dL. This is above EHAP's blood lead reference value of 5µg/dL, and is also above the 25 µg/dL reference value for adults established by the Centers for Disease Control and Prevention (CDC). When using these same concentrations and exposure assumptions for pregnant women, the probability that fetal blood lead would exceed the target blood level of 10µg/dL is 93.2%. This result shows that exposure to lead could harm the fetuses of pregnant women. Full information regarding the application of the Adult Lead Model can be found in Appendix C.

Teenage Children

Adolescent children are another group that accesses the site. Since young adults have developing bodies, they are more vulnerable and more sensitive to lead poisoning than adults (see Appendix D for a child-specific public health statement about lead). Therefore, a different lead exposure model was used. EHAP used a model developed by ATSDR (ATSDR, 2007). This equation uses values from selected lead exposure studies, which provides a cumulative exposure estimate expressed as total blood lead. For adolescent children, EHAP made several assumptions. First, the children here are teenagers and young adults. There is no evidence that young children and toddlers are playing on the East Parcel beach.

This model also used the maximum reported concentration of lead, 13,400 ppm. EHAP also assumed that a teenage trespasser visited this area of the site three days per week (156 days per year) for four hours per day. This exposure assumption assumes a teenager may come to the site four days per week in the summer and fall, and two days per week in the winter and spring – this number was based on exposure frequencies used in the Portland Harbor Public Health Assessment (ATSDR, 2011). This exposure frequency is also meant to be conservative, or protective, of human health. An extended presentation of the model used to evaluate lead risks in older children is contained in Appendix E.

The maximum blood lead level predicted by ATSDR's model was 17.5 µg/dL, which is above EHAP's threshold level of 5 µg/dL. This level is also above CDC's blood lead reference value of

5 µg/dL. This indicates that incidental swallowing of contaminated beach soil at the East Parcel beach of Willamette Cove would likely result in adverse health effects in teenagers and young adults who regularly trespass onto the East Parcel beach.

Physical Hazards

Hazards on the East Parcel beach are shown in Figures 9 and 10. Areas of land that are below the high water mark are the responsibility of the Oregon Division of State Lands. These hazards were most obvious during the August 2011 site visit, when water levels are seasonally at their lowest. Evident features at the East Parcel beach include several jagged metal pieces sticking out of the sand, and broken treated pilings sticking out of the sediment. On the north side of the East Parcel beach, there is a large scaffold-type structure made of metal beams and concrete; this structure is covered with graffiti. There is no indication of how old or sturdy the structure is. The jagged pieces of metal present a risk to people walking on the beach. The pilings present a risk to waders, swimmers, and boaters at the site. It is unknown what else lies under the sand at the beach and under the sediment in the water. The scaffolding could collapse, or someone could fall from the top of it. The entire East Parcel beach would be extremely dangerous for any water-based activity, especially at night and during high water when the hazards may not be visible.

Uncertainty

In any public health assessment there are uncertainties. Some of the uncertainty is related to the health guideline values used to assess toxicity (*i.e.*, MRLs and RfDs). These values have passed a rigorous multi-agency peer-review process; however, each individual is unique and individuals vary in their sensitivity to toxic chemicals. To some extent, these uncertainties have been addressed by applying uncertainty factors (*e.g.* dividing the doses where effects were observed by numbers ranging from 10 to 1,000). The intent of this practice is to protect human health by building in a safety margin to these guideline values.

Another area of uncertainty has to do with the dose reconstruction. This type of uncertainty has two parts – the concentration in soil to be used for dose reconstruction, and the amount of soil people come into contact with. With lead, it was possible that a certain spot of soil would have a higher concentration than those measured. Due to the small number of samples, it was not possible to statistically calculate an upper confidence limit of the mean. Therefore, EHAP used the maximum reported value. This is intended to protect human health by leaning towards overestimation of the true average soil concentration. It should be noted that the samples EHAP evaluated are from one area of the East Parcel beach. The site has not been fully characterized.

It is impossible for EHAP to know exactly how much soil and dust a person accidentally swallows every day. In the absence of that type of specific information, we used standard default values that are developed by ATSDR, and are based on studies that measured how much soil people eat when they are doing every day activities. EHAP used the averages from these types of studies assuming that they would be representative of the people mentioned in this Willamette Cove East Parcel Beach Health Consultation. Where there was uncertainty about these defaults, EHAP tried to overestimate exposure to be protective of health despite unavoidable uncertainty.

Children's Health Considerations

EHAP and ATSDR recognize that infants and children may be more vulnerable to exposures than adults in communities faced with contamination of their air, water, soil, or food. This vulnerability is a result of the following factors:

- Children are more likely to play outdoors and bring food into contaminated areas.
- Children are shorter, resulting in a greater likelihood to breathe dust, soil, and heavy vapors close to the ground.
- Children are smaller, resulting in higher doses of chemical exposure per body weight.
- The developing body systems of children can sustain permanent damage if toxic exposures occur during critical growth stages.
- Children are more likely to swallow or drink water during bathing or when playing in and around water.
- Children are more prone to mouthing objects and eating non-food items like toys and soil.

Because children depend on adults for risk identification and management decisions, EHAP is committed to evaluating their special interests at and around the Willamette Cove East Parcel beach site. In this HC, children are identified as especially vulnerable to exposure to lead and dioxin in the soil. Many children spend a significant amount of time playing outdoors, making contact with the ground, digging in the soil, and exploring. EHAP's conclusions and recommendations take children's' activities into consideration and has designed conclusions and recommendations that, if followed, will protect children from potentially dangerous exposures to lead.

Conclusions

EHAP reached *three* important conclusions in this Health Consultation.

1) Incidentally swallowing lead-containing beach soil at the East Parcel beach at the Willamette Cove site on a regular basis could harm the health of children and adults who use this area (156 days per year for children and 182 days per year for adults). Due to the levels found, EHAP considers the East Parcel beach an area of public health concern. High levels of lead measured in the soil could cause decreased intelligence and impaired neurobehavioral development in children and fetuses. There is no "safe" level for blood lead concentration in children and adults.

2) There is not enough evidence to conclude that people could experience health effects from contacting dioxin-containing surface soil on the East Parcel Beach of the Willamette Cove. This is because EHAP does not have evidence that people are coming into contact with dioxin-contaminated soil on a regular basis.

3) Trespassing on the upland area near the East Parcel beach on old scaffoldings, walking or playing on the East Parcel beach where metal debris is sticking out of the ground, or using the water along the East Parcel where numerous underwater hazards are present could result in *physical injury.* This is a physical safety hazard. The scaffold is old and not maintained. People could be cut by or trip over pieces of metal sticking out on the beach. People could trip on or be cut by physical hazards in the water; boaters could collide with underwater hazards.

Recommendations

Based on EHAP's analysis of the available information about the Willamette Cove East Parcel beach site, EHAP has developed recommendations that, if followed, will protect public health from the hazards identified in this Health Consultation.

EHAP is proposing the following specific recommendations and guidelines that will protect the public at the East Parcel Beach of Willamette Cove.

EHAP recommends that people:

- Avoid the entire Willamette Cove site. If people choose to go into this area, take care to avoid direct contact with the sandy soil on the East Parcel beach. People should wear shoes and avoid sitting in the soil. People on the beach should not have cooking fires or engage in other activities where hands and skin can come into contact with the sandy soil.
- Walking through this area remove shoes before entering their home to avoid tracking soil into living areas. For those walking dogs through this area, wash the dog's feet and legs thoroughly before allowing into the home.
- Anchoring boats and other vessels in the cove along the East Parcel beach avoid bringing their boats too close to the shore, and not visit or walk on the sandy beach area.
- Do not play on or go near areas where there are physical hazards on or near the East Parcel Beach. This includes the old scaffolding along the shoreline, in-water hazards that are submerged or protruding from the water, and metal sticking out of the ground on and around the beach.
- Who catch fish along the shores of the Willamette Cove site heed the Portland Harbor fish advisory, which states:
    - Women ages 18-45, particularly pregnant or breastfeeding women, children under 6, and people with weak immune systems, thyroid or liver problems, should avoid eating resident fish from Portland Harbor, especially carp, bass and catfish. "Resident" fish are those that spend their entire lives within a certain territory, and do not migrate. Non-resident, migratory fish such as Salmon, Steelhead, and Lamprey are not included in this advisory.
    - Large and older sturgeon is expected to have higher levels of PCBs and should be restricted like carp, bass and catfish.
    - Healthy women beyond childbearing age (over 45 years old) and healthy adult males should restrict the amount of resident fish eaten from Portland Harbor to no more than one meal per month.
    - All persons should reduce or avoid eating fatty parts of fish.
    - Removing and throwing away the skin, fat, eggs, and internal organs will reduce exposure to PCBs in fish.

    Oregon fish advisories can be found at: www.healthoregon.org/fishadv

EHAP recommends that partner agencies and potentially responsible parties:

- Take additional surface soil samples in the East Parcel beach area, so that lead contamination can be further characterized and remediated at a future date. EPA should take into consideration the lead contamination in the East Parcel beach as they move forward with the Portland Harbor cleanup.
- Federal and state environmental agencies should prioritize the Willamette Cove site sampling and clean-up because the site is easily accessed and heavily used by the public.
- Further characterize dioxin in surface soils in the area adjacent to the East Parcel beach, as well as in other areas of the Willamette Cove site, to ensure that it does not pose a health risk.
- Post signs at the East Parcel beach, warning people of chemical contamination. These signs should be visible to people approaching the beach from the upland area and to boaters approaching the beach from the water.
- Consider characterizing potential contamination at the Central Parcel beach of the Willamette Cove site.
- Maintain current site closure and continue efforts to keep people from camping, making fires or recreating at Willamette Cove.
- Consider ways to further eliminate physical hazards in the area. This includes access to scaffoldings, in-water hazards, scrap metal, and rebar sticking out of the ground.

Public Health Action Plan

The public health action plan for this report contains a description of actions that have been or will be taken by EHAP and other government agencies at the Willamette Cove site. The action plan is designed to ensure that this Health Consultation both identifies public health hazards and provides a plan of action designed to reduce and prevent adverse health effects resulting from exposure to hazardous substances in the environment. Included is a commitment on the part of EHAP to follow up on this plan to ensure that it is implemented.

Public Health Actions that have been implemented to date:

- Metro, the owner of the upland area, regularly checks to make sure trespassers are not on the upland area of the site. This reduces access to the East Cove beach area by discouraging people who walk through the upland area to the beach.
- Metro has posted “no trespassing” signs in the upland area. In the summer of 2012, Metro placed temporary plastic signs at the East Parcel beach, and is planning permanent signs that explain chemical hazards.
- EHAP provided Metro with multiple-language signs that explain the Portland Harbor fish advisory. These signs were posted near the shore on the Willamette Cove site.
- DEQ and potential responsible parties are working together to further characterize contamination on the East Parcel beach and upland areas of Willamette Cove.
- EHAP toured the site in November 2010, August 2011, and July 2012. EHAP has been in contact with DEQ and potential responsible parties to talk about public health issues on the site.

Public Health Actions that will be implemented in the future:

- EHAP will work with Metro and nearby residential neighborhoods to identify effective ways to reduce the number of people accessing the site.
- EHAP will coordinate with DEQ and potential responsible parties to identify future public health concerns on the Willamette Cove site, including:
    - Evaluating additional data for lead contamination on the East Parcel beach, and dioxin contamination near the beach, when it becomes available.
    - Evaluating contamination data for other chemicals on the East Parcel beach.
    - Evaluating potential public health issues in the upland area of the Willamette Cove site.
    - Evaluating potential public health issues in the West Parcel beach area of the Willamette Cove site.
- EHAP will work with partner agencies to make sure that physical hazards on the site are removed or rendered inaccessible.
- EHAP will conduct a community needs assessment of the Willamette Cove site.
- EHAP will present the results of this document to interested parties.

Report Preparation

This Health Consultation for the Willamette Cove site was prepared by the Oregon Health Authority (OHA) under a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with the approved agency methods, policies, and procedures existing at the date of publication.

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Appendix A. Comparison Values and Contaminant Screening

This appendix defines the various comparison values (CVs) that were used in this Health Consultation and describes the hierarchy by which they were chosen. This process is also explained in Chapter 7 of ATSDR's Public Health Assessment Guidance Manual [ATSDR, 2005]. Appendix A also explains the contaminant screening process.

CVs used in this document are listed below:

Environmental Media Evaluation Guides (EMEGs)
EMEGs are an estimate of contaminant concentrations low enough that ATSDR would not expect people to have a negative, non-cancerous health effect. EMEGs are based on ATSDR Minimal Risk Levels (MRLs, described below) and conservative assumptions about the public's contact with contaminated media, such as how much, how often, and for how long someone may be in contact with the contaminated media. EMEGs also account for body weight.

Minimal Risk Levels (MRLs)
A MRL is an estimate of daily human exposure – by a specified route and length of time - to a dose of a chemical that is likely to be without a measurable risk of negative, noncancerous effects. MRLs are based on ATSDR evaluations. Acute MRLs are designed to evaluate exposures lasting 14 days or less. Intermediate MRLs are designed to evaluate exposures lasting from 15-364 days. Chronic MRLs are designed to evaluate exposures lasting for 1 year or longer. Oral exposures (swallowing the contaminant) are measured in milligrams per kilogram per day [mg/kg/day] and inhalation exposures (breathing the contaminant) are measured in parts per billion [ppb] or micrograms per cubic meter [$\mu g/m^3$].

Regional Screening Levels (RSLs)
RSLs are contaminant concentrations in soil, water, or air, below which any negative health effects would be unlikely. RSLs are derived by EPA, using risk assessment guidance from the Superfund program. They are risk-based concentrations derived from standardized equations combining exposure information assumptions with EPA toxicity data. RSLs take into account both non-cancer and cancer risks. RSLs are available online at:
(http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm)

EHAP uses the hierarchy shown in Figure A1 (Adapted from Figure 7-2 in ATSDR's Public Health Assessment Guidance Manual [ATSDR, 2005]) to choose CVs for screening purposes.

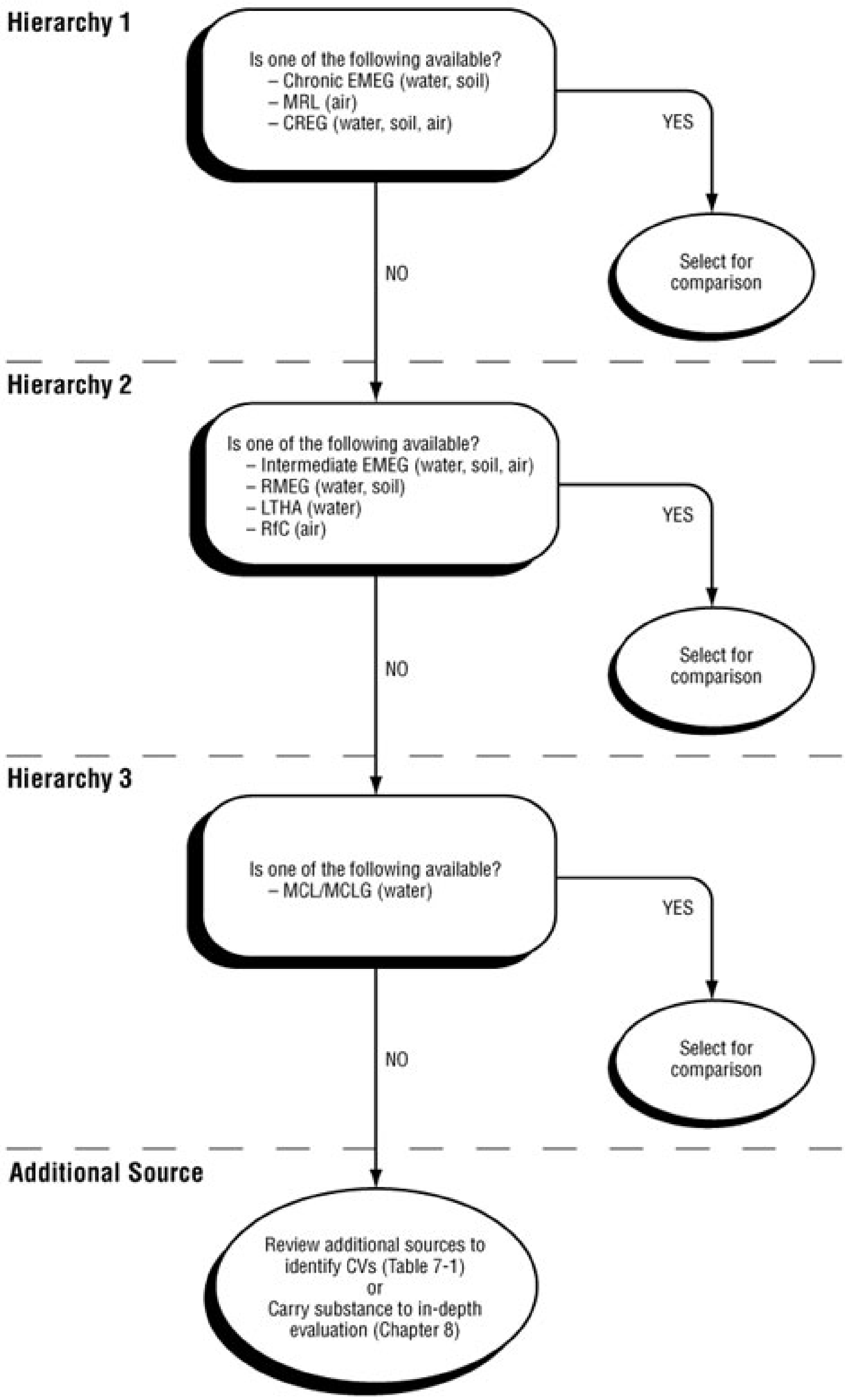

Figure A1. Environmental Guideline Hierarchy

Appendix B. Dose and Health Risk Calculation for Dioxin

This appendix describes the formulas, methods, and assumptions used to calculate dioxin doses. The doses calculated here were used to calculate the risk for people potentially exposed and to determine whether that exposure would result in illness because of dioxin from a small area near the East Parcel beach. This is protective of human health because it uses the highest concentration found at the site. People will likely be exposed to lower concentrations of these COPCs. To calculate dioxin doses, EHAP used the TEQ concentration that was reported (Ash Creek, 2011). This approach is conservative (*i.e.*, protective of nearly all populations) of health. See Table B-1 for more details about terms in the formula and he values used for each with their rationale. Doses were calculated as follows:

<u>Dose from exposure to beach soil:</u>
Chronic dose

These formulas were applied to the dioxin exposure scenario, where children could be exposed to dioxin-contaminated soil regularly over the course of months or years.

Total Dose = Oral Dose + Dermal Dose

$$\text{Oral Dose} = \frac{C \times IR \times CF \times EF \times ED}{AT \times BW}$$

$$\text{Dermal Dose} = \frac{C \times CF \times SA \times SAF \times DAF \times EF \times ED}{AT \times BW}$$

Where :
C = Concentration of dioxin measured in soil (mg/kg)
IR = Ingestion rate of soil (mg/day)
CF = Conversion factor (kg/mg)
SA = Skin surface area exposed to soil (cm^2)
SAF = Soil Adherence factor – how much soil sticks to skin per square centimeter ($mg/cm^2/day$)
DAF = Dermal Absorption factor – what percentage of chemical in soil can actually pass through the skin (chemical specific)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
AT = Averaging Time (days)
BW = Body Weight (kg)

<u>Non-cancer vs. Cancer dose</u>

Methods for calculating doses for use in assessing non-cancer risk and for cancer risk are identical except the way in which averaging time (AT) is calculated. See below for details:

Non-Cancer:
AT = ED x 365 days

Where:
AT = Averaging time
ED = Exposure duration (years)

Cancer:
AT = 28470 days (78 year lifetime x 365 days/year)

The rationale for this difference in AT lies in the theory that cancer is the result of multiple defects/mutation in genetic material accumulated over an entire lifetime. Therefore, the averaging time is representative of an entire statistical lifetime (78 years) for agents that cause cancer.

Table B-1. Exposure Factors for Chronic Dose Calculation for a child trespasser exposed to dioxin

Term	Description	Value	Units	Rationale
C	Concentration	0.0057	mg/kg	Concentration of dioxin sample
IR	Intake rate for soil ingestion	100	mg/day	ATSDR Guidance (ATSDR, 2012a)
C_1	Conversion Factor 1	0.000001	kg/mg	Converts kilograms of soil to milligrams of soil
EF	Exposure frequency for ingestion and dermal contact with of soil	52	Days/year	Professional judgment. A child playing in dioxin-contaminated area would access the site once per week.
ED	Exposure Duration	2	years	A two year, continuous exposure period for an adolescent (11 years and greater)
BW	Body weight	64.2	kg	ATSDR default for older children ages 11 through 20 years (ATSDR, 2012a)
AT_{nc}	Averaging time for non-cancer health effects	730	days	ED x 365 days
AT_c	Averaging time for cancer health effects	28470	days	78 year lifetime x 365 days – lifespan of 78 years recommended by ATSDR (ATSDR, 2012b)
SA	Exposed skin surface area for soil contact	4200	cm^2	Sum of surface area for hands, upper arms, and lower legs of child 11 years old and greater (ATSDR, 2012b)
SAF	Soil adherence factor	0.2	mg/cm^2-day	ATSDR Guidance for TCDD and other dioxins(ATSDR, 2012b)
DAF	Dermal absorption factor	0.03	---	Dermal absorption factor for 2,3,7,8-TCDD (ATSDR, 2012b)

Appendix C. Dose and Health Risk Calculation for Lead in Adult Trespassers

The Adult Lead Model (ALM) is designed to estimate adult blood lead concentrations and determines the probability that fetal blood lead concentration will be greater than the target blood lead value of 5 µg/dL. Table C1 shows the results of the ALM using the default input parameters and a soil lead concentration of 13,400 ppm. For activities involving the Reasonable Maximum Exposure (RME) to East Parcel beach soil (100 mg/day soil ingestion rate) and a soil concentration of 13,400 ppm, the predicted blood lead of an adult trespasser on the site is 33.6 µg/dL, and the probability that fetal blood lead will exceed target blood lead level of 10 ug/dL is 93.2%, based on the exposure frequency of 182 days/year. This predicted adult level is above CDC's reference value for adults of 25 µg/dL *and* EHAP's threshold of 5 µg/dL. There is no safe level of blood lead. EHAP considers lead in East Parcel beach soil to be at levels of concern to adult trespassers on this area of the Willamette Cove.

All input parameters for the ALM are further described in Table C-1. It is important to note that the adult lead model relies on many input parameters to estimate blood lead levels. EPA developed default values for all parameters to allow the model to be used without performing costly and time-consuming site specific studies. Several of these parameters can be measured more accurately on a site-specific basis. In the absence of site-specific data, this evaluation uses default values. These default values could lead the model to over-predict or under-predict actual blood lead levels.

Table C-1. Input perimeters for the ALM results for adults on the Willamette Cove East Parcel beach.

Variable	Description of Variable	Units	Value
PbS	Soil lead concentration	ppm	13,400
$\mathbf{R_{fetal/maternal}}$	Fetal/Maternal PbB ratio	--	0.9
BKSF	Biokinetic Slope Factor	µg/dL per µg/day	0.4
$\mathbf{GSD_i}$	Geometric Standard Deviation	--	2.1
$\mathbf{PbB_0}$	Baseline PbB	µg/dL	1.5
$\mathbf{IR_s}$	Soil Ingestion Rate (including soil-derived indoor dust)	g/day	0.10
$\mathbf{W_S}$	Weighting factor; fraction of IR_{S+D}	--	--
$\mathbf{K_{SD}}$	Mass fraction of soil in dust	--	--
$\mathbf{AF_{S,D}}$	Absorption fraction (same for soil and dust)	--	0.12
$\mathbf{EF_{S,D}}$	Exposure frequency (same for soil and dust)	days/yr	182
$\mathbf{AT_{S,D}}$	Averaging time (same for soil and dust)	days/yr	365

Appendix D. How can lead affect children?

A public health statement from the Agency for Toxic Substances and Disease Registry's *Toxicological Profile for Lead* (ATSDR, 2007).

HOW CAN LEAD AFFECT CHILDREN?

This section discusses potential health effects in humans from exposures during the period from conception to maturity at 18 years of age. Studies carried out by the Centers for Disease Control and Prevention (CDC) show that the levels of lead in the blood of U.S. children have been getting lower and lower. This result is because lead is banned from gasoline, residential paint, and solder used for food cans and water pipes.

Children are more vulnerable to lead poisoning than adults. Children are exposed to lead all through their lives. They can be exposed to lead in the womb if their mothers have lead in their bodies. Babies can swallow lead when they breast feed, or eat other foods, and drink water that contains lead. Babies and children can swallow and breathe lead in dirt, dust, or sand while they play on the floor or ground. These activities make it easier for children to be exposed to lead than adults. The dirt or dust on their hands, toys, and other items may have lead particles in it. In some cases, children swallow nonfood items such as paint chips; these may contain very large amounts of lead, particularly in and around older houses that were painted with lead-based paint. The paint in these houses often chips off and mixes with dust and dirt. Some old paint contains as much as 50% lead. Also, compared with adults, a bigger proportion of the amount of lead swallowed will enter the blood in children.

Children are also more sensitive to the health effects of lead than adults. No safe blood lead level in children has been determined. Lead affects children in different ways depending on how much lead a child swallows. A child who swallows large amounts of lead may develop anemia, kidney damage, colic (severe "stomach ache"), muscle weakness, and brain damage, which can ultimately lead to death. In some cases, the amount of lead in a child's body can be lowered by giving the child certain drugs that help eliminate lead from the body. If a child swallows smaller amounts of lead, such as dust containing lead from paint, much less severe but still harmful effects on blood, development, and behavior may occur. In this case, recovery is likely once the child is removed from the source of lead exposure, but there is no guarantee that the child will be completely free of the long-term consequences of lead exposure. At still lower levels of exposure, lead can affect a child's mental and physical growth. Fetuses exposed to lead in the womb, because of high levels of lead in their mothers, may be born prematurely and have lower birth weights. Exposure in the womb, in infancy, or in early childhood also may slow mental development and cause lower intelligence later in childhood. There is evidence that these effects may persist beyond childhood. Children with high blood lead levels do not have specific symptoms. However, health workers can find out whether a child may have been exposed to harmful levels of lead by taking a blood sample. They can also find out how much lead is in a child's bones by taking a special type of x-ray of the finger, knee, or elbow. This type of test, however, is not routine.

Appendix E. Dose and Health Risk Calculation for Lead in Adolescent Children

Lead (Pb), was one of the COPCs identified for people exposed to soil while trespassing in the East Parcel beach of the Willamette Cove site. Because scientists, including toxicologists, chemists, and medical doctors, have been studying Pb for so long, there is sufficient information to calculate blood Pb concentrations (PbB) in micrograms per deciliter (µg/dL) based on concentrations in various media. The process described here estimates the total PbB from all sources in the environment and not only from the Willamette Cove. EHAP used site-specific information about exposure and Pb concentrations where known. For non-site-specific exposure scenarios, defaults established by EPA and approved by ATSDR were used. EHAP used 5 µg/dL PbB as the threshold for adverse health effects in adolescents.

The basic formula used to calculate PbB at the Portland Harbor Superfund Site is:

$$PbB = \delta_S TPb_{soi} + \delta_S TPb_S + \delta_D TPb_D + \delta_W TPb_W + \delta_{AO} TPb_{AO} + \delta_{AI} TPb_{AI} + \delta_F TPb_F$$

Where:

δ = Media specific slope factor. This term is used to estimate how Pb concentration in each media translates into PbB in µg/dL.

T = Relative time spent in contact with each media. Table D1 shows the assumptions used for this term for each medium.

Pb = Concentration of Pb in each medium.

Table E-1 shows the meanings of terms in the above formula, the range of estimated PbB from each media, and overall PbB for children trespassing at the Willamette Cove East Parcel beach.

Table E-1. Blood Lead Levels for children at the Willamette Cove East Parcel beach

$PbB=\delta_S TPb_{soi} + \delta_S TPb_S + \delta_D TPb_D + \delta_W TPb_W + \delta_{AO} TPb_{AO} + \delta_{AI} TPb_{AI} + \delta_F TPb_F$					Slope Factor (δ)[1]		Blood Lead (µg/dL)	
Media	**Term in Formula**	**Concentration (Pb)**	**Units**	**Relative Time Spent (T)**	**Low**	**High**	**Low[2]**	**High[3]**
Outdoor Air	AO	0.0071[4]	µg/m^3	0.07[5]	1.53	2.46	0.00076	0.001223
Indoor air	AI	0.0021[6]	µg/m^3	0.93[7]	1.53	2.46	0.0030	0.004804
Food	F	5[8]	µg/day	1	0.014	0.034	0.070	0.17
Water	W	4[8]	µg/L	1[9]	0.03	0.16	0.12	0.64
Soil (site-wide maximum)	Soi	13400[10]	mg/kg	0.07[11]	0.0011	0.016	1.03	15.0
Soil from off-site	S	70[8]	mg/kg	0.93[12]	0.0011	0.016	0.072	1.0416
Dust	D	70[8]	mg/kg	1	0.0021	0.0096	.147	0.672
Total	---	---	---	---	---	---	**1.4**	**17.5**

Note:
µg = micrograms; m^3 = cubic meters; kg = kilograms; L = liter; Pb = lead

The total estimated PbB (17.5µg/dL) is above the 5 µg/dL threshold that EHAP uses as the threshold for adverse health effects in adolescents. This is also above CDC's reference value of 5 µg/dL. Currently, there is no demonstrated safe concentration of lead in blood. Research has shown that measured health effects can occur at levels as low as 2.5 µg/dL (EPA, 2000). According to the 2007-2008 National Health and Nutrition Examination Survey (NHANES), the average blood lead for children ages 12 to 10 years of age was 0.8 µg/dL. The high estimate is over 20 times higher than this average concentration. EHAP considers lead in East Parcel beach soil to be at levels of concern to children playing there.

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1 Slope Factors for children; from: ATSDR, *Toxicological Profile for Lead*, D.o.H.a.H. Services, Editor. 2007: Atlanta, GA.
2 Calculated using low slope factor
3 Calculated using high slope factor
4 Six year average (2003-2008) ambient air Pb concentration measured at National Ambient Air Quality stations within 2 miles of the site
5 4 hours a day for 156 days a year spent playing at the East Parcel beach divided by 24 hours a day for 365 days in a year (4 hrs * 156 days / 8760 hrs = 0.07)
6 EPA recommends using 30 percent of outdoor air concentration for indoor air
7 Any time not spent playing in the East Parcel beach area (1.00-0.07 = 0.93)
8 Taken from ATSDR, *Toxicological Profile for Lead*, D.o.H.a.H. Services, Editor. 2007: Atlanta, GA.
9 Assumes tap water, not site-specific surface water. EHAP chose this value because the default Pb concentration in tap water was higher than the average concentration of lead in surface water at the site. Using the default tap water value is more protective of health.
10 This is the maximum reported value from the three samples taken at the East Parcel beach.
11 100% of the relative time spent playing in the East Parcel beach (1.00 x 0.07 = 0.07).
12 Contact with soil from anywhere other than in-water sediment from the East Parcel beach (1.00-0.07 = 0.93)

Appendix F. Glossary

This glossary defines words used by EHAP in communication with the public. It is not a complete dictionary of environmental health terms. If you have questions or comments, call EHAP's toll-free number, 1-877-290-6767.

Absorption	How a chemical enters a person's blood after the chemical has been swallowed, has come into contact with the skin, or has been breathed in.
Adverse Health Effects	A change in body function or cell structure that might lead to disease or health problems.
ATSDR	The **A**gency for **T**oxic **S**ubstances and **D**isease **R**egistry. ATSDR is a federal health agency in Atlanta, Georgia that deals with hazardous substance and waste site issues. ATSDR gives people information about harmful chemicals in their environment and tells people how to protect themselves from coming into contact with chemicals.
Blood Lead Level	A measure of lead in the body. It is measured in micrograms of lead per deciliter of blood (μg/dL).
Cancer	A group of diseases which occur when cells in the body become abnormal and grow, or multiply out of control.
Cancer Risk	The probability that cancer will occur over the course of a person's lifetime.
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act. It is also known as **Superfund**. This act concerns releases of hazardous substances to the environment, and the cleanup of these substances and hazardous waste sites.
Chronic Exposure	A contact with a substance or chemical that happens over a long period of time. EHAP considers exposures of more than one year to be *chronic*.
Comparison Value	Concentrations of substances in air, water, food, and soil that are unlikely, upon exposure, to cause adverse health effects. Comparison values are used by health assessors to select which substances and environmental media (air, water, food and soil) need additional evaluation while health concerns or effects are investigated.
Concentration	How much or the amount of a substance present in a certain amount of soil, water, air, or food.
Dermal Contact	A chemical getting onto your skin.

Dose	The amount of a substance to which a person may be exposed, usually on a daily basis. Dose is often explained as "amount of substance(s) per body weight per day".
Duration	The amount of time (days, months, years) that a person is exposed to a chemical.
Environmental Contaminant	A substance (chemical) that gets into a system (person, animal, or the environment) in amounts higher than the **Background Level**, or what would be expected.
US Environmental Protection Agency (EPA)	The federal agency that develops and enforces environmental laws to protect the environment and the public's health.
Exposure	Coming into contact with a chemical substance.
Exposure Point Concentration (EPC)	An estimate of the concentration of a chemical in a medium at an exposure point.
Exposure Assessment	The process of finding the ways people come in contact with chemicals, how often and how long they come in contact with chemicals, and the amounts of chemicals with which they come in contact.
Exposure Pathway	A description of the way that a chemical moves from its source (where it began) to where and how people can come into contact with (or get exposed to) the chemical. ATSDR defines an exposure pathway as having 5 parts: 1. Source of Contamination, 2. Environmental Media and Transport Mechanism, 3. Point of Exposure, 4. Route of Exposure, and 5. Receptor Population. When all 5 parts of an exposure pathway are present, it is called a **Completed Exposure Pathway**.
Frequency	How often a person is exposed to a chemical over time; for example, every day, once a week, or twice a month.
Ingestion	Swallowing something, as in eating or drinking. It is a way a chemical can enter your body.
Hazard Index	A summation of the hazard quotients for all chemicals to which an individual is exposed.

Hazard Quotient	A comparison of an estimated chemical intake (dose) with a reference dose level below which adverse health effects are unlikely.
Health Consultation (HC)	A review of available information or collection of new data to respond to a specific health question or request for information about a potential environmental hazard. Health consultations are focused on a specific exposure issue.
Health Guideline	A daily dose of a chemical, below which scientists consider it unlikely to harm people's health.
kg	Kilogram or 1000 grams. Usually used here as part of the dose unit mg/kg/day meaning mg (contaminant)/kg (body weight)/day.
Lowest Observed Adverse Effect Level (LOAEL)	The lowest concentration or amount of a substance found by experiment or observation that causes an adverse health effect in an organism.
mg	Milligram or 1 thousandth of 1 gram. Usually used here as in a concentration of contaminant in soil mg contaminant/kg soil or as in the dose unit mg/kg/day meaning mg (contaminant)/kg (body weight)/day.
Minimal Risk Level (MRL)	**M**inimal **R**isk **L**evel. An estimate of daily human exposure – by a specified route and length of time **--** to a dose of chemical that is likely to be without a measurable risk of adverse, noncancerous effects. An MRL should not be used to predict adverse health effects.
National Priorities List (NPL)	The **N**ational **P**riorities **L**ist (which is part of **Superfund**). A list kept by the U.S. Environmental Protection Agency (EPA) of the most serious uncontrolled or abandoned hazardous waste sites in the country. An NPL site needs to be cleaned up or is being looked at to see if people can be exposed to chemicals from the site.
Non-cancer Risk	The probability that any adverse health effect that is not cancer will occur as the result of a person's exposure to a substance.
Point of Exposure	The place where someone can come into contact with a contaminated environmental medium (air, water, food or soil). Some examples include: the area of a playground that has contaminated dirt, a contaminated spring used for drinking water, or the backyard area where someone might breathe contaminated air.
Potentially Responsible Party (PRP)	A possible polluter who may eventually be held liable under CERCLA for the contamination or misuse of a particular property or resource.

Source of Contamination	The place where a chemical comes from, such as a landfill, pond, creek, incinerator, tank, or drum. Contaminant source is the first part of an Exposure Pathway.
Toxic	Harmful. Any substance or chemical can be toxic at a certain dose (amount). The dose is what determines the potential harm of a chemical and whether it would cause someone to get sick.